

a minimum dew-point temperature of 20 degrees Fahrenheit, while supplying purified water for up to 12 Soldiers at a time. During FY06, TARDEC plans to demonstrate water recovery units on Heavy Expanded Mobility Trucks, Family of Medium Tactical Vehicles and Humvees, and both the standalone system and the vehicle-integrated system will be ready for military vehicle integration by 2007.

The WRUE has the capability to generate drinking water by capturing water from fuel expended by engines on the battlefield. This system can be embedded into current and future military platforms and will also feature low energy and lightweight devices that have the ability to purify water on combat platforms.

For each gallon of fuel that is consumed by the vehicle, a half-gallon of drinkable water is recovered for the Soldier. The WRUE system will enable warfighters to operate without an external resupply of water for an extended period.

Military bridging is also a major UA concern. TARDEC's Bridging Simulation

Laboratory, located at Selfridge Air National Guard Base, MI, features computer-controlled load test areas that are equipped with automated data acquisition capabilities for structural testing of bridging systems. Both static and dynamic structural load applications are available for structural and fatigue tests.

TARDEC is testing advanced composite materials to see how useful they will be for building a tactical bridge. Under the Advanced Modular Composite Bridge program, TARDEC will determine if the composite material solutions are capable of bridging gaps of 13, 20 and/or 26 meters for Future Force applications. TARDEC is working with the threshold load of a fully loaded Future Tactical Truck System (FTTS) towing an FTTS trailer with a mission load class of 45-70 tons. This initiative is a direct follow-on program of the highly successful Composite Army Bridge and the Modular Composite Bridge programs. The Defense Advanced Research Projects Agency is a major contributor to this effort.

TARDEC's ability to rapidly respond to the immediate needs of Soldiers in theater is an organizational characteristic.

TARDEC has fielded life-saving solutions to Soldiers while continuing to develop robust Future Force programs.

While the United States enters a new century of warfighting, TARDEC is ensuring that we understand and meet our Armed Forces' needs and expectations. When Soldiers make suggestions, TARDEC listens. When the Army calls, we respond. As the Army transforms into a more modular, stabilized and flexible force, TARDEC, with more than 50 years of experience, is leading the way — relevant and ready — developing superior technology for a superior Army.

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## Robots at War — Revolutionary Warfare Supporting the Homeland and Abroad

Ashley John

Robots are playing a revolutionary role on the battlefield as the Army continues to fight the global war on terrorism (GWOT). Keeping Soldiers out of harm's way by using unmanned systems has become an operational requirement that has transitioned from original Future Force applications into Current Force operations. From small

robots that inspect the underside of vehicles to 20-ton robots that have the capability to engage threats, the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) is at the forefront of developing unmanned systems to ensure that the Current Force is lighter, reconfigurable and increasingly

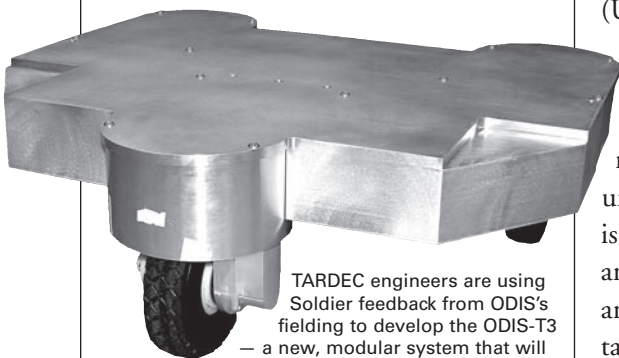
deployable against enemy threats both on U.S. soil and abroad.

The GWOT has forced advanced robotics program technology to be spun into current operations. This has resulted in an onslaught of robotics technology quickly reaching the hands of warfighters at home and abroad.

As part of the original Future Combat Systems (FCS) requirements, TARDEC robotics engineers have been researching and developing robotic navigation and mobility platforms for many years. This knowledge base has proven key to responding quickly to Soldiers' unmanned system needs during current operations.

## ODIS

Advanced robotic mobility research has led to the successful development of the Omni-Directional Inspection System (ODIS) family of robots. ODIS is a robotic delivery platform capable of mounting various chemical and biological sensors to its base. The robot is equipped with a visual camera and an active lighting system, which forms its basic mission package. Like a hovercraft on wheels, ODIS can move forward or backward, left or right and rotate separately or in combination. This unique feature allows the operator to precisely position and maneuver ODIS under a vehicle to view cavities, wheel wells and spaces above and around structural members.



TARDEC engineers are using Soldier feedback from ODIS's fielding to develop the ODIS-T3 — a new, modular system that will be outfitted with a modular wheel design to allow the wheels to be interchanged on the fly and traverse tougher terrain. (U.S. Army photo by TARDEC.)

ODIS has been deployed to various checkpoints in the Central Command theater of operations. According to ODIS Chief Engineer Bill Smuda, who helped field 20 robots in Iraq and Afghanistan, "The Soldiers really liked the technology and were very quick to pick up the use of it." Additional

feedback from Soldiers in Iraq has resulted in the development of additional payloads to assist in standoff attempts, including a camera mast system to enable operators to see inside vehicles while operating from remote locations.

ODIS is also helping to defend the homeland by aiding in the detection of bombs and other explosive devices that terrorists may smuggle into the U.S. checkpoints and seaports. The U.S. Capitol Police Bomb Squad Hazardous Materials Unit uses ODIS to perform reconnaissance on vehicles and other suspicious objects. Seaport security units and other police agencies are also using ODIS robots.

Since ODIS's successful fielding, TARDEC engineers are gathering more Soldier feedback and using it to explore what other future technologies can be spun into Current Force applications. Through the use of feedback and engineer philosophy, TARDEC recently completed prototype designs of the Under Vehicle Inspection System (UVIS).

## UVIS

Similar to ODIS, UVIS is a small robotic platform that can inspect the underside of vehicles. However, UVIS is smaller, more maneuverable, wireless and outfitted with a first-class camera and lighting system. UVIS is a notably low-cost, standoff solution with the potential ability to support every military checkpoint. UVIS houses a reliable and simple teleoperation capability that focuses on user interface and short user training periods. TARDEC is now looking at alternative payloads for UVIS, one of which encompasses explosive detectors.

UVIS will feature an omnidirectional system — comparable to ODIS —



Soldiers at a checkpoint in Baghdad, Iraq, are trained by TARDEC engineers on how to properly use the ODIS robot. TARDEC engineers used their knowledge of FCS robotics' mobility needs to quickly field ODIS for Central Command use. (U.S. Army photo by TARDEC.)

that can be driven in any direction from any starting point, giving the user extreme ease of use and excellent situational awareness. This capability comes from three independently rotating wheels and an advanced control system. This system can translate user commands via the joystick into commands for the wheel-positioning motors. UVIS was fabricated with a high-quality, tiltable camera system that is fashioned with a ring light-emitting diode that provides a clear and lighted view of the vehicle's underside. TARDEC Research Scientist Dr. Robert Karlsen remarked, "Anywhere you use ODIS, you can use UVIS." Thus far, UVIS has been used for pre-event security sweeps at large inauguration festivities. Karlsen further explained, "The best application for these robots includes investigating mines and improvised explosive devices, exploring rooms and looking in caves. Since robots haven't become autonomous yet, they must be remote controlled or teleoperated."

## Chaos

Providing vehicle inspection standoff isn't the only unmanned technology on which TARDEC is focused. TARDEC and industry partner Autonomous Solutions Inc. (ASI) are pushing the limits of small robotics technology

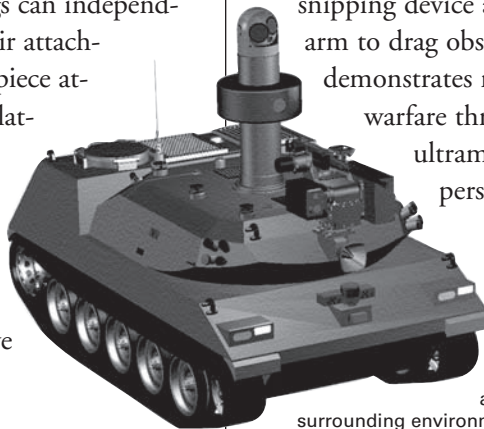
through a newly developed robot named Chaos. Stemming from the PackBot lightweight unmanned reconnaissance and tactical warfare vehicle, Chaos has a combination of four legs, wheels and tracks, giving it extreme mobility performance in a small package.

"You can envision each of the legs as being an elongated circular end with a straight piece in between. This piece can rotate with the track running around it," Karlsen stated. Each of Chaos's tracks and legs can independently rotate about their attachment axis, with each piece attached to either the platform's mid or end point. This increased flexibility allows for amplified maneuverability, giving Chaos an extensive assortment of gaits.

Intended for off-road environments, Chaos is enhanced with various gait controls and self-extraction behaviors. Chaos can also operate successfully in cluttered urban terrain or anywhere that a Soldier needs a small vehicle with high mobility. Ultimately, Chaos will be able to recognize the terrain it is on or about to encounter, and switch into a mode that will be optimal for that specific environment. A prototyped Chaos has already

demonstrated its ability to walk up and down stairs and to drive in severe off-road environments.

To increase Chaos's perception, two separate camera systems have been fitted to the platform. One system is in the vehicle's front to be used for driving, and the other camera is secured to extend vertically, allowing for augmented perception. Production for Chaos is predicted to begin in 2006, and ASI is looking to add a wire-snipping device and a mobility arm to drag obstacles. Chaos demonstrates revolutionized warfare through its rugged, ultramobile, all-terrain personality.



The ARV Robotic Technologies ATO will increase unmanned platforms' perception technology to provide an accurate view of the surrounding environment and will develop mission behavior technologies to enable tactical maneuverability. (Photo courtesy of U.S. Army TARDEC and BAE Systems.)

## Research and Development (R&D)

Even while supporting current operations, TARDEC is continuing its Future Force R&D, where it will not be uncommon to see vehicle-class unmanned systems on the battlefield and in logistics roles. TARDEC is home to three major robotics' Advanced Technology Objectives (ATO). These include Human-Robot Interaction in Soldier-Robot Teaming, Robotic Follower Advanced Technology Demonstration and Armed Robotic Vehicle (ARV) Robotic Technologies.

The ARV ATO gives unmanned platforms an increase in perception technology to provide an accurate view of the surrounding environment, while simultaneously developing mission behavior technologies to supply the capability to tactically maneuver the unmanned ground vehicle (UGV).

"This ATO will examine current UGV vulnerabilities, improving survivability through the development of unique anti-tamper countermeasures," explained TARDEC Program Engineer Jeff Jaster. "A surrogate platform will be integrated with the advanced technology software and associated hardware developed under this effort, as well as appropriate mission modules to support warfighter experiments and evaluations in military environments."

The ATO will begin modifying a surrogate platform for future technology insertions of subsystems that will be integrated onto the platform for initial field evaluations in 2006. According to Jaster, ARV is a solid example of how TARDEC will take technological advances and transition them through Unit of Action systems for spin-out integration — leading to rapid deliverables for Soldiers.

As the Army continues to fight the GWOT, TARDEC — with its intelligent systems' core competencies — will continue to spin robotic technology into the Current Force while working with the Lead Systems Integrator to develop future robotic vehicle platforms.

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Partnered with industry, TARDEC prototyped the first Chaos robot. Lightweight and man-portable, Chaos uses various mobility platforms to scale the most difficult terrain. (Photo courtesy of Autonomous Solutions Inc.)